USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2006CA172B

Title: Impacts of Ethanol on Anaerobic Production of Tert-Butyl Alcohol (TBA) from Methyl Tertiary Butyl Ether (MTBE) in Groundwater

Project Type: Research

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Congressional District: 44

Focus Categories: Groundwater, Water Quality

Keywords: MTBE, TBA, groundwater contamination, bioremediation, anaerobic biodegradation, microorganisms, groundwater treatment, organic pollutants

Principal Investigator: Scow, Kate

Federal Funds: $11,554

Non-Federal Matching Funds: $23,456

Abstract: The widespread use of the gasoline oxygenate MTBE and subsequent spills or leaks of MTBE- laden fuel into the environment has resulted in numerous groundwater supplies becoming contaminated with MTBE. In California alone it is estimated that at least 10,000 groundwater sites currently have MTBE levels above the CA drinking water standard (> 5 ppb) (19). MTBE is a human health concern and relatively recalcitrant under the anaerobic conditions commonly found at gasoline spill sites. Therefore, Ethanol is rapidly replacing MTBE as the preferred fuel oxygenate. The increasing use of Ethanol amended gasoline (gasohol) is the motivation for this work. The preferential degradation of ethanol in anaerobic environments rapidly consumes predominant electron acceptors (e.g. nitrate, sulfate, iron), thus spills of gasohol can reduce an aquifer's redox potential to methanogenic conditions. Recent evidence indicates that MTBE may be partially degraded to tert-butyl alcohol (TBA) under methanogenic conditions by acetogenic bacteria. Whereas MTBE is a suspected carcinogen and a nuisance chemical in drinking water, TBA is a known toxin, more water soluble than MTBE, and more

difficult to remove from water. The biological, geochemical, and environmental factors that influence the formation of TBA from MTBE under methanogenic conditions are not well understood. With an improved understanding of which organisms and environmental factors are involved in anaerobic TBA formation we may be able to design remediation protocols that could prevent TBA from becoming California's next major environmental problem.

The objective for this proposal is to determine the role of acetogenic bacteria in the anaerobic transformation of MTBE to TBA under methanogenic conditions and assess the influence of ethanol exposure on this process. We will measure rates of transformation of MTBE to TBA by pure cultures of acetogenic bacteria and in anaerobic microcosms constructed from aquifer sediments gathered from an MTBE-contaminated aquifer at Vandenberg Air Force Base. In addition, we will correlate acetogenic bacterial abundance with TBA concentration in water samples from the same aquifer. Thus we propose to use WRC funds to further analyze field samples already sampled, thereby leveraging existing funds (from CA Dept. of Health Services), while answering questions not supported by our current funding. DNA fingerprinting and quantitative PCR techniques will be used to correlate the presence and abundance of acetogenic bacteria with TBA production. We will use innovative and traditional microbiological techniques to isolate, identify, and characterize acetogenic bacteria responsible for MTBE bioconversion to TBA in situ.

This research has the potential to lend insight into the mounting evidence that MTBE partially biodegrades under methanogenic conditions to TBA. Recent observations at our field site suggest that this biologically catalyzed reaction is significantly accelerated in the presence of ethanol. Due to the widespread nature of MTBE contamination in California and the current ubiquity of gasohol, the potential for future gasohol releases impacting MTBE contaminated groundwater is high. This research is necessary to understand the potential outcome of gasohol release on MTBE contaminated water supplies.
